

"Aye, it's delicious, but that's no' how y' make porridge!" Personal writing for learning in a science education PhD

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Abstract

This paper reports on a particular approach to doing a doctorate in which the first author has used personal writing to increase the relevance, autonomy and quality of her learning and to allow her to present her study, her personal reactions to the study and the experiences that have led her to the study in one thesis. The personal writing consisted of reflective and critical journal and letter writing through which Mary dealt with the affective, social and moral factors she believed to be an integral part of deep learning in a social science. The paper describes how, as well as having consequences for her research on improving autonomy, motivation and learning in Year 8 science students, this has led her to present her PhD thesis on two levels: science education and narrative.

The PhD serves two main objectives. The first is made quite explicit by PhD Handbooks (e.g., QUT, 1993, p. 2): the student researcher is required to produce "an original and substantial contribution to knowledge". The second, which is less explicit, but which is nevertheless implied in the type of thesis examination required, is to investigate and become proficient in the process of doing research in an ethical manner in one's chosen area (Phillips & Pugh, 1990).

Hence, doing a doctorate is an experience in learning. As a consequence, therefore, it does not make sense for PhD students in education to ignore recent developments in educational theory when it comes to their own theses. If what we know about learning processes has undergone evolution, then how learning is represented in reports or representations--such as the PhD thesis--could also be expected to have evolved. However, in spite of rhetoric about "the social construction of meaning" (Driver, 1988; Tobin, 1993), it has been our experience that it is difficult for doctoral students in science education research to break out of the shackles of traditional experimental notions of research. Even when qualitative methods are used, we find that a linear program within a single paradigm has been assumed and

findings are expected to be "objective". It is our experience that both subjectivity and discussion of changes in epistemological beliefs are discouraged in doctoral studies. However, we believe that it is more consistent with recent developments in educational theory for such factors to be accepted and reported as a legitimate part of the learning process in a doctorate.

The traditional model for a thesis in science and science education consists of a literature review leading to the definition of a problem and a plan for investigating it, a pilot study or at least the development and testing of instruments, and the main study, followed by the results, conclusions and discussion. This is all expected to be in the third person and written as though the knowledge produced is objective, and can be related to a conceptual framework which remains more or less stable from the beginning to the end of the research.

Consequently, any personal account of the research experience is considered at best irrelevant, and at worst, a sign of lack of rigour, and any major changes in epistemological beliefs, rather than being recognised as signs of progress and development, are simply seen as disasters, since they mean that the research will have to be reformulated all over again within the new paradigm, as though the original path taken had been a dead end, lost time. This position seems to assume that the linear, objective, mono-paradigmatic account is the best model for reporting how the research has been done, regardless of how the learning for the researcher has actually taken place. It is obviously the standard model for a report of an investigation, or for the testing of a hypothesis, but is it a good model for a report of learning from research in a prolonged study such as a PhD?

One reason for the high rate of attrition in postgraduate research studies may be a clash between students who want their PhD to be personally meaningful and supervisors who resist this approach, favouring the 'You have to jump through the traditional hoops to get your PhD, whether they make sense to you or not'. Since a personally meaningful thesis is more motivating and more self-sustaining, this may also lead to doctorates done with a heavy heart and gritted teeth, and doctorates not even begun, perhaps especially for women.

We would like to suggest that insisting that doctoral students adhere to the traditional report form of representing their research, may in fact reinforce positivistic approaches to learning (including research) the limitations of which have been well recognised in the last few decades. The traditional scientific model seems, to us, to give an over-simplified picture of how learning happens and what knowledge is, since it presents learning as a more or a less linear, impersonal and individualistic process resulting in knowledge which may be detached from the personal, cultural and historical context of the researcher.

This paper explores these issues in the context of a particular case, a PhD in science education. It relates how the first author, Mary, found that her experience of the power of personal writing to clarify her ideas, nurture her conceptual development and illuminate her research, was reinforced by her reading of the education literature, where it was argued that rational approaches to conceptual change teaching, which did not allow for affective and social factors, had little impact on the strongly-held naive beliefs that students held about the physical world. It describes how Mary discovered that at some level all her learning during her research involved personal (including affective) and social (including moral and ethical) factors, and as a result she arrived at the conclusion that, not only did these factors need to be addressed during the research process, but also that their part should be documented in the representation of the research in the PhD thesis.

To do this, the present paper looks at the relationship between the objective and the subjective, between the observed and the observer and between the scientific and the personal, and, in this, the paper itself exhibits this dichotomy, discussing it with two voices.

The Scientific Method

In my case, I naively assumed that producing new knowledge would be the hard part and that the methodology would be simply a matter of adopting and following a set of procedures already available in the literature. Similarly the question of ethics seemed to present no problem, as I had no intention of cheating or harming anyone. The further I have gone in this PhD process, however, the more I realise that the construction of knowledge, the methodology used, and ethical considerations are all intimately connected. The PhD has become a journey for me, a search for the research methodology which is capable of allowing me to participate fruitfully in the construction of new knowledge in the

field of education in a way which is just and equitable to other participants.

Consequently, I wish to argue that the fact that so far I have seriously adopted, questioned and distanced myself from various distinct schools of thought, should not be seen as a sign of fickleness and superficiality on my part, but rather as progress along a dimension of awareness of what knowledge is, how meaning is constructed by humans, and what diverse purposes research can serve. In so doing, I could be said to be aiming to fulfil a third objective of the PhD, again rarely made explicit but which is represented by the "Ph" in that designation - to raise questions about the meaning of the knowledge being produced or constructed. Because I see the PhD in these terms, I see my own task of making "an original and substantial contribution to knowledge" as being a larger process than that of doing and

reporting some linear process of empirical research, from a supposedly objective or, at least stable, viewpoint. For me the research is much more of a hermeneutic process, with its meaning being rewritten many times along the way, as the whole is continually being reconceptualised in the light of new learning.

For these reasons, it is being proposed that the research will be reported at two interconnected levels, one level reporting the separate research project activities and their outcomes as they are experienced with the co-participants--the science education research, and the other level reporting the reflexive process of analysing the research process itself--the narrative inquiry. Since the overall process is a process of change over time, the research as a whole is most easily conceived of as the development of a narrative (Connelly & Clandinin, 1990), a jointly-developed narrative, with many participants, but told by one narrator who takes responsibility for, and at the same time critiques, the view of intersubjective reality presented, at each stage and as a whole.

There are many parallels between the two levels of study, since in fact they both focus on deep learning (or conceptual change), on the relationship between doing activities and learning, on the importance of reflection in learning, on the place of affect and values in learning, and hence of the impact on learning of the psychosocial learning environment, including the broader cultural setting. Furthermore they both explore ways of deepening and broadening learning, particularly using collaborative groups and reflective writing. In both cases it is argued that deep learning is not a rational, linear process, devoid of emotional content, but rather that learning is a recursive and personal process, in which knowledge is reshaped, broadened and deepened, and in which prior knowledge is questioned and reconceptualised, so that it becomes more intelligible, plausible and fruitful.

Is the traditional model of a thesis how scientists, whether in the natural or social sciences, usually develop theories that advance thinking in their particular areas of knowledge, or is their research process at once more iterative and developmental, more personal and creative, and generally more collaborative and political? There is support for a more flexible approach to research in the social sciences. For instance, Stenhouse (1980, p. 244), arguing for action research as the most appropriate methodology for research in education, commented,

"Progress in human affairs is not like progress in physical sciences: as we begin to see the lines on which to design a strategy for solving the puzzle, the puzzle itself is changed."

As in Stenhouse's comment, this alternative direction for social science usually involves differentiating social science research from

physical science research, but are they really so different? There is evidence that producing new knowledge in the physical and natural sciences can be a creative and collaborative enterprise, and one in which language is developed at the same time as new theories are being created. Kekule is well-known for his creativity in deducing a ring model for the benzene molecule from a dream he had about snakes who turned around to grasp their own tails, but he is less well-known for setting up a meeting of European scientists to work out a common system for naming or symbolising the chemicals that were being documented. Another scientist and a father of modern chemistry, Michael Faraday, wrote,

"You can hardly imagine how I am struggling to exert my poetical ideas just now for the discovery of analogies and remote figures respecting the earth, sun, and all sorts of things--for I think that is the true way (corrected by judgment) to work out a discovery" (in a letter to C. F. Schoenbein in 1845, cited in Sutton, 1992, frontispiece).

If knowledge in science advances in these complex ways, is there much point in continuing to insist on representing research as a simple logico-deductive process described in language whose meaning has been arrested?

Two Levels of Research

As my research progressed, it became increasingly difficult for me not to apply the implications of my developing theories about conceptual change, to my own learning and reporting process as a fledgling researcher. This began while I was studying the importance of metacognition to expert learning, and with a conviction that I had to be metacognitive about my own learning processes and goals, including emotional components which may have been affecting learning. Later, after being exposed to ideas about the sociocultural nature of learning, I also became convinced about the importance of acknowledging the part played in learning by sociocultural factors such as beliefs (particularly motivational beliefs), values and attitudes.

As I read more of the literature coming from an interpretivist (e.g., Erickson, 1986), constructivist (e.g., Guba & Lincoln, 1989; Bruner, 1990) or interactional sociolinguistic perspective (e.g., Collins & Green, 1992), and became more convinced of the cultural embeddedness of language (and therefore of knowledge conveyed as language), I saw my individual production of knowledge as being necessarily shaped by my personal place in my own cultural context. This seemed a natural extension of the notion that knowledge is context-dependent, and thus should be reported in relation to that context (with myself being part of the context). Consequently I saw a need to openly report relevant aspects of my personal context, such as my beliefs, values, biases, and agenda. This is supported by Walkerdine's (1994, AARE keynote address)

argument that since subjectivity in social research is "impossible to avoid", the researcher should decide "how to use it as a feature of the research project itself." She argued that "the way that I'd been brought up to see the world, my very subjectivity, created, produced...the social world itself" and hence necessitated "[taking] seriously the position from which I thought, felt, observed and wrote."

My belief in the necessity of revealing the subjective aspects of my development of knowledge was reinforced by the influence of critical social science theory, particularly critical educational science theory as proposed by Kemmis and his colleagues (e.g., Carr & Kemmis, 1986), since it advocated the bringing to consciousness and critical examination of implicit theories, through (collaborative) critical action research, in order to find inconsistencies and or contradictions, sometimes referred to as 'false consciousness.'

Consequently, as I began to apply my theory of learning to my own research process, as I began to see myself as part of the context of knowledge construction, and as I began to adopt a critical, self-reflexive stance in relation to my research, narrative began to seem eminently suitable as a way of reporting my research process or journey. For me, the search for a research method which was congruent with my intellectual and ethical beliefs, was as important as finding a topic worthy of investigation. Narrative inquiry, since it allowed for change, even including radical change, during the research process, also allowed me to maintain my integrity in how I went about doing and reporting my research. It freed me from the traditional constraint of reporting the research as though it all belonged within a single paradigmatic structure, and was reported by a single voice. A narrative inquiry research design could incorporate change as an integral and even necessary part of the process of constructing knowledge. It also seemed to me to represent a truer model of how most complex knowledge is constructed than the neater, 'theory-practice-conclusions,' linear model suggests.

For me this was particularly significant because my philosophical and methodological commitments underwent changes several times during my research, each change necessitating a new research plan. Thus, for the first three studies I undertook, although they did not become the main study or lead directly to it, nevertheless they provided me with a deeper level of knowledge for reflection on the particular research problem I had chosen, on the purpose of research and on the most suitable methodology for satisfying my research aims. Not including them on the grounds that they were 'false starts' or 'dead ends', seems to me to imply a model of learning which ignores the importance of prior relevant learning to further learning.

In an attempt to both study students' learning of science and reflect on her role in the PhD, Mary divided the aims and objectives of her PhD into two parallel and interdependent sets: the science education aims

and objectives which refer to the classroom research (this is what Mary originally thought would be the whole of her research); and the narrative or metalevel aims and objectives, which refer to her personal context as she experienced and interpreted the entire research process.

The science education aims were to explore the effects of the psychosocial learning environment on student engagement for conceptual change in science classes, and to search for approaches, based on peer learning and personal writing, of facilitating the type of environment thought most likely to be promote scientific literacy. More specifically, this research had the following objectives:

- (1) to investigate in depth at least one secondary level science class, in terms of factors related to the quality of students' cognitive engagement for conceptual change;
- (2) to develop, using the findings above and an analysis of her findings in the literature, a model of the science classroom as a learning environment which could enhance conceptual change;
- (3) to partially explore the soundness of the model referred to in (2), by examining the relationship between factors, as defined by the model, and as operationalised in a learning environment questionnaire designed for a specific science class; and
- (4) to explore the soundness of the model for understanding cases of daily practice, and, by collaborating with several teachers and their students in secondary science classrooms, to find ways of realising it, for example, by including personal writing and peer learning in regular classroom activities.

The narrative aims were to make explicit the journey of the researcher involved in making "an original and substantial contribution to knowledge" (QUT, 1993, p. 2). In this context, the metalevel objectives of this research which were formerly implicit now became explicit:

- (5) to search for a rational and just method of doing research in science education, through reading of the available literature, through discussion with other research participants, and other members of the educational research community, and through reflective journal writing;
- (6) to critically evaluate both her practice as an educational researcher and also the quality of her contribution to the construction of knowledge through the research process; and
- (7) to report on this process of critical appraisal of both her research practice and of the value of the knowledge contributed, in the form of a self-reflexive narrative.

For us, reporting the personal context, that is, reporting on the historical events and philosophical outlook which framed the science education research project, is essential for a coherent reading of how and why the research was done and came to the stated conclusions. Reporting the whole process also has the advantage of being a truer account of the process than is possible when only the final "successful" outcomes of research are reported.

Mary developed a three stage research design for the two levels of

objectives. Stage 1 covered exploratory studies in which Mary trialled different approaches to research. There were three exploratory studies: a first participant observational study of a secondary science class in which participation was minimal, a survey study of a larger number of science students to investigate the relationship between variables of interest, and a second, more collaborative participant observational study in another secondary science class. The three exploratory studies were encompassed in the narrative inquiry out of which they grew and in relation to which they take their meaning. The narrative inquiry had three main themes: the development of knowledge about science learning in classrooms, the development of understanding of the practical and ethical implications of different methods of doing research, and the development of understanding of what it means to produce new knowledge. Part of the first narrative inquiry theme--developing knowledge about science learning in classrooms - took the form of model-building which continued throughout most of the period of the three exploratory studies. The process consists of synthesising findings, which included those gained by revisiting the literature, into a new theory of science learning. This is similar to the first part of a 'Phase 2 project' as explained by Woods (1985) and results in another kind of grounded theory - theory which is grounded in an analysis of previous research. The previous research analysed can be from a variety of perspectives and may be cross-disciplinary. The resultant theory is then further tested in ongoing research studies.

Stage 2 was the final classroom study, whose methodology would be based on conclusions reached at the end of Stage 1 about the most ethical and useful way of doing research on science education, and would be framed as the process of facilitating an extended action research study or two or three smaller action research studies by science teacher practitioners concerned with how the classroom environment could facilitate learning in science. As such, this would necessitate critical self-reflection about her role as a facilitator, so that the two levels of investigation would merge into a single analysis of her practice as a facilitator, including an evaluation of this as a method of researching her science education objectives.

In Stage 3, Mary would draw together reflections on all three themes. This process would be one of updating theory about learning in science classrooms, synthesising findings about the practical and ethical considerations of doing collaborative research with teacher-practitioners, and, finally, developing understanding of what it meant to produce new knowledge as a PhD student studying science teaching and learning.

Narrative Inquiry

At the beginning of my PhD, I thought that writing a reflective journal

would help me to learn more deeply. I had used it in a professional development course on adult literacy teaching and had found that it allowed me to draw more useful conclusions from the readings and lectures than I otherwise would have. It also helped me to integrate my new learning with my practical experience in the classroom, in a way which was exciting and challenging and opened up new avenues to my own professional development. Before I began my PhD, a prospective supervisor suggested I keep a reading journal. At that stage it was simply a means of reflecting on my readings, but it soon started to evolve and to serve more functions and eventually became the framework through which I was able to make sense of my research and of the research process itself.

Prior to the PhD, my research experiences, two literature review subjects and two research subjects, had showed me that my feelings, as long as they were unresolved, could seriously interfere with my analytical processes. And this was compounded by the fact that what I chose to research was inevitably something about which I felt strongly but which still presented me with problems. Before I could analyse the data I was dealing with in a insightful, unclouded manner, I had to sort out irrational feelings such as shame, doubt, inadequacy, anger, fear, adulation or pride, that might otherwise absorb half my concentration whenever I started reading or thinking about my subject-matter.

I dealt with my mixed feelings partly by reading. I read anything and everything that might throw light on why I felt the way I did and explain why I had turned out the way I did. This reading phase helped me to feel better about myself and let me give all my attention to the more generally interesting questions that the literature seemed to throw up.

When it came to the writing phase, I needed a second period of dealing with my attitudes to separate out the rational from the less rational. I found that I needed to do a first writing in which I let out all my heartfelt conclusions about the topic: heated criticisms of what seemed to me unreasonable arguments or inadequate research, elaborations of what the conclusions might mean, enthusiasms for particular ideas and arguments, and admissions of where there were gaps in my own arguments.

This was never intended to be seen by any eye other than mine, and would not have worked if I had been censoring it in any way at all. Once I had expressed this multitude of ideas which had been clamouring for a hearing, I could see what I really had there on paper before me, what the main issues were, and what the evidence for and against them was worth. I could see the hyperbole in my writing for what it was--usually an attempt to compensate for arguments which were not strong enough on their own. But it was also in this stage that I was most creative and insightful and saw new relationships which had not been apparent to me before. I do not believe I would have had these insights if I had tried to be perfectly objective and had repressed

anything with emotional content.

Writing the research report then became relatively straight-forward. What the main question was and how the writing should be structured seemed to become clear. Somehow, having had the chance to express my own personal concerns and values allowed me to see more clearly just what were personal concerns and what was more generally important about the findings of my study. My reports were not uniformly insightful--there were often still parts that I had not thought through clearly enough, but I know that overall the reports were much more penetrating than they would have been if I had tried to ignore the emotional content that for me was associated with the subject matter.

Before I began my PhD, however, I did not consciously go through this process. It was only after I had been through it several times that I began to see a pattern in my way of dealing with difficult learning projects. And it was only after active experience with explicit journal-writing activities, and after meeting the concept of metacognition, that the pattern started to become more apparent and meaningful, and it was not until well into my PhD--when my journal-writing method of clarifying my ideas was being questioned by a previous supervisor, that I realised the importance of the personal writing stages in my overall research process.

As well as being a personally meaningful research methodology, narrative, which has always played an important part in social science more generally, has also recently begun to play a growing role in research in education, and more recently still, to play a part in research in science education. The narrative inquiry research method enables the accommodation of an ethical concern, one shared with critical educational theorists such as Carr and Kemmis (1986), a concern about the relationship between theory and practice, or, more positively, a concern for an equitable relationship between researchers and practitioners. According to Connelly and Clandinin (1990, p. 12), [W]hat is at stake is less a matter of working theories and ideologies and more a question of the place of research in the improvement of practice and of how researchers and practitioners may productively relate to one another....Our own work then becomes one of learning to tell and live a new mutually constructed account of inquiry in teaching and learning. What emerges from this mutual relationship are new stories of teachers and learners as curriculum makers, stories that hold new possibilities for both researchers and teachers and for those who read their stories.

Narrative inquiry appears to be able to offer the chance to bridge the divide between researchers and practitioners by allowing practitioners a voice in the construction of new knowledge in the form of the jointly constructed narrative.

That narrative inquiry has the potential to result in such a narrative

which provides a more accessible and compelling record of the shared research to other practitioners than a purely discursive account, is a further advantage. According to Connelly and Clandinin (1990, p.10), "the principal attraction of narrative as method is its capacity to render life experiences, both personal and social, in relevant and meaningful ways."

Journal Writing and Changing Alternative Conceptions in Science

For my PhD, I began with two separate files, one for reflections on where I was going with my PhD, and one for comments on my readings which, coincidentally, were at this stage focused on ideas about metacognition and its role in deep learning. I was challenged by the idea put forward by Paris and Winograd (1990), that metacognitive practices, since they were associated with evaluation of one's own processes inevitably provoked feelings such as pride, happiness, shame or despair, which could then affect motivation and learning. I was also impressed by a review of studies in reattribution training for discouraged learners by Borkowski, Carr, Rellinger, and Pressley (1990), who concluded that three factors were interdependent in their affect on the emergence of self-regulated learning: metacognition, motivational, and personality constructs. This reinforced what I had learnt in psychology from cognitive behavioural therapists such as Aaron Beck, who showed how automatic everyday thoughts could be irrational and affect one's motivational beliefs, and how this could be combated by bringing out the hidden thoughts for a rational analysis. I became convinced that learning could not fail to be enhanced when learners paid critical attention to their everyday thoughts and feelings about their research.

Being metacognitive as defined by such writers meant not only thinking about one's subject-matter, but also thinking about one's own thinking process and taking control of it. I realised it would make better sense if I combined my personal journal and my annotated bibliography and did not keep my thinking about my research question separate from my thinking about my learning processes. I also started to include other thinking about my research in it, for example, a long letter to my original supervisor about my concerns that we were not likely to be compatible, and a poem I wrote in protest when he dismissed Piaget as being out of date, and told me not to bother reading any of his writing. My journal soon became a place for me to explore my feelings about what was going on in the PhD process, at the same time as exploring the validity of the research and theories I was developing.

At the beginning it was a very private diary, a conversation with myself, but as time progressed, it became a place for me to dialogue with or about absent theorists and sometimes such writing developed into letters to distant academics who seemed willing to act as mentors to me for a period of time. What this meant was that the self-criticism contained in my journal-writing at the beginning was of a confessional nature, a private examination of my conscience to see if

I was being intellectually honest, and much of my argument could remain implicit. As time went by, and my imagined audience expanded to take in people who might not accept my reasoning as easily as I myself would, my self-criticism became more socially based, and I had to make my arguments more explicit, with the result that I became increasingly aware of both my own assumptions and also those of others involved in the dialogue. I started to see the social and ethical issues involved in research and to take a more critical view of the practice of research in my own and other institutions.

However other ways of understanding what it means to create or refine knowledge are common. Besides being found in other education research circles, new epistemologies are, in fact, exemplified in some science education research writings and are to be found incorporated in current theories of science pedagogy, such as social constructivism. In spite of this fact, the implications of such epistemological beliefs for PhD study are still largely unexplored in the field of science education.

Reading in the science education research literature indicated that what were initially called 'misconceptions' loomed large as a problem area. It seemed that students were learning the accepted scientific theories in the classroom and could use them to solve standard classroom problems and pass tests, but that when they were put to the test in a problem-solving situation in a different context, they reverted to naïve theories which they had somehow preserved intact alongside their school learning (Osborne & Freyberg, 1985; Posner, Strike, Hewson & Gertzog, 1982; White & Gunstone, 1989).

Researchers had tried to solve this problem of the persistence of 'alternative beliefs', as they were later renamed, but such beliefs seemed amazingly resistant to change. Various pedagogies were proposed to challenge the alternative beliefs. For example the PEEL project grew out of research in science teaching and learning which demonstrated that teachers could help students to learn in a more meaningful way by giving them metacognitive strategies to use, the type of strategies that successful students used (Baird, 1986; Baird & Northfield, 1992). However, students quickly found ways of using metacognitive strategies without being metacognitive, and it seemed that the problem of superficial learning was far from being solved (White & Baird, 1991). Paris and Winograd's caution that one could not get students to evaluate their own learning, self-evaluation being an integral part of metacognition, without raising emotional responses, including negative ones which could lead to negative attributions and decreased engagement in learning. The cognitive science approach often seemed to me to lack strategies and theories to deal with the emotional and volitional components of learning. The expert-novice literature, however, seemed to me to suggest it was the will to learn and attain deep understanding in a particular domain that lead to the use of metacognitive strategies, rather than the reverse (Jones & Idol, 1990). Other approaches to the conceptual change problem were based in a

social constructivist epistemology (Driver, 1988), and relied on enculturation by small group learning to challenge individual naïve conceptions, with the social context providing the motivational impetus for learning.

The problem seemed to me to become one of motivating students to be intrinsically interested in learning, which would not be an easy task since it would mean first overcoming negative beliefs which students had about themselves as learners, about learning and about their subject matter. However, Mary believed that students could be given back their faith in themselves as learners, their delight in learning, and their enjoyment of science learning, and the more she read the more convinced she became. Collins, Brown & Newman's (1989) 'cognitive apprenticeship' model, demonstrated, using illustrations from three successful methods of teaching, that learning could be successful for all learners if it provided a social context which reinforced positive motivational beliefs, and treated every individual's learning as socially valuable. Pintrich, Marx, and Boyle (1993) also argued that the sociological context was vital to the motivational beliefs necessary for cognitive engagement, and pointed out their likely importance to conceptual change teaching in science. Watts and Bentley (1987) gave support to such arguments by emphasising the need for a non-threatening learning environment if students were to expose and investigate their prior learning in science as part of conceptual change learning.

One strategy which teachers could use to give students messages to encourage positive motivational beliefs and provide a safe environment for the deconstruction of old scientific beliefs and accommodation of new learning is collaborative group work. However, small group work can be difficult for some individuals unless there is a large amount of support which may not be available. Therefore, the strategy learnt in the professional development course in adult literacy education was chosen: personal or journal writing. In her experience of teaching literacy to adult learners Mary had found that a warmly encouraging and non-judgmental environment could work wonders with students with weak self-efficacy beliefs, and journal writing, used appropriately, appeared to have the potential to provide such an environment.

Reflections and Conclusions

My initial proposal was for an intervention study using role allocation in small groups and metacognitive strategies to help students learn from their practical investigations in science, and it was to include allowing students to be metacognitive about their motivational beliefs as well as about their other learning processes. It included pre- and post-tests, with some qualitative data being thrown in to reinforce and explain my objective findings, a typical positivist approach to research.

Unfortunately for my plans for a short PhD but fortunately for my continued development, I was introduced to, and converted to 'interpretive' research and offered a chance to undertake a classroom study with a focus on the learning environment by a visiting scholar. Coming from a very objectivist stance, I initially found such research very difficult as the data seemed so nebulous, but gradually I came to see that such research allowed a more sophisticated insight into learning through classroom research than my previous positivistic approach, which began to seem more and more inappropriate for research in social situations where so many variables were interacting. The context, or rather how it was interpreted by the participants in it, and how this developed as a mini-culture over time, could no longer be ignored as mere 'noise' in my data. Such factors became, in fact a prime source of data. My conception of the importance of context in research also deepened with my reading of Bruner (1990), which convinced me that meaning making was a personal and social experience and depended on cultural narratives for much of its sense.

So I gave up my idea of an intervention and set to reading Erickson (1986) and Guba and Lincoln (1989), observing in a classroom setting, and doing interviews. My discomfort with being an interpreter of the learning environment evaporated but a new one came in its place. There seemed to me to be something patronising about researchers coming in with preconceptions and theories of their own, through which filter they interpreted the culture, and then went away and reported the 'participants' view of the learning environment'. I could not believe that the participants (teachers and students in schools) were in an equitable enough position of power to control the interview situation so that their particular viewpoint was adequately represented or to properly critique a script given to them for member checking by researchers with 'Dr' or 'Professor' in front of their name. I was also unhappy with ethnographic research because I could not see how it would lead to change in schools, unless it could involve the members of the school community more actively in decision-making and problem-solving about the interpretation of the problems and the finding of solutions to them. Such restraints led to indecision on my part, dissatisfaction with my progress by others, and a hold-up in my research proposal.

This was only resolved when I decided to let that research project go and to plan a new one which would involve research of a much more collaborative and problem-solving nature, and action research then presented itself as a near perfect solution for me, not only because it was geared towards change, or because it involved the participants of the research itself in the decision-making process, but because it also addressed issues such as power inequities, and seemed to allow for more critical reflectivity than the previous research methodologies I had tried. I had not lost sight of my 'research problem' though I had had to pretend to have when I went into the ethnographic research with a supposedly open mind. I still wanted to find a way of using personal

writing in science to help students overcome barriers to learning with deep understanding. So I set about finding a teacher or group of teachers with similar concerns and interests to collaborate with me in research, and continued writing up my still incomplete research proposal.

There was one other study which I will not go into since it mainly served as my last point of resistance before I would let go my ties with the secure world of statistical analysis and venture out in the world of qualitative analysis. This was a questionnaire study involving over 100 students, using a questionnaire I wrote based on a model of a possible conceptual change learning environment that I had been developing during my first classroom study. The results seemed to support my theory, with highly statistically significant results, but it became even more obvious to me that such quantitative studies could not explain findings, and hence were not very useful as a guide for pedagogical changes for more effective learning.

At this stage I found that philosophically there was a widening gap between me and some of the people I had been working with, who had little sympathy for my belief in the power of personal writing in a non-threatening learning environment, who saw my desire to empower teachers and students as somewhat foolish, and who had little understanding of the importance to me of my own subjective journal-writing as a method of clarifying ideas and moving forward in my research. I felt very unsupported in what to me were very important issues, and realised that I would never come up with a proposal that would be highly acceptable to them.

Back to Square 1? No, not at all. I believed that I had made much more progress in my knowledge about research and learning in my research so far than if I had gone ahead with my initial proposal, without questioning the paradigm, or thinking about issues of subjectivity, and of ethics in dealings with other members of the research community. I started to see the bits and pieces that had made up the previous two years as being highly significant learning experiences which would have just as much influence on my final conclusions as would the final study I planned to do. I decided that as such they should be a legitimate part of my research plan, and I started to see the falsity for me of pretending that I was doing a single study, with perhaps one of my earlier studies being smuggled in as a pilot study. I also began to see the need to give a more personally reflective account of my research. If it were true that a knowledge of the context, as it is perceived by actors in a situation, is crucial to the interpretation of the actions which take place in that situation, then, for readers of my research, my personal characteristics and beliefs, and my history, could not be ignored as mere 'noise'. If I myself were to be the 'instrument of research' (Guba & Lincoln, 1989), then the results of my research would be influenced by my philosophies and biases, based in turn on my personal

and cultural background. This led to my decision to include such personal factors in the account of my research to the extent that I perceived them to be relevant to my interpretation of what I was observing. But not only should such personal factors be included in the final account of the research, to allow the reader to decide for him or herself how they had influenced the findings, but also, as Valerie Walkerdine argued in her address to AARE last year, they should be included in one's ongoing analysis of the research, so that the researcher herself could achieve some insight into their influence while the research was still in progress.

As far as we can generalise from Mary's case, her use of journal writing has promoted deep learning and a questioning, critical attitude that led to both personal and intellectual growth, and professional development in her practice as a researcher. Because it related her learning to personal issues, it also promoted a high degree of commitment to the research process, and gave her the necessary motivation to bear the frustrations and to respond to the many challenges which doctoral study almost inevitably provides.

She also found that the results were similar when Year 8 students used journal writing in a science class. Allowing students in one class to have their personal reactions to learning accepted as real and meaningful, seemed to reduce the resistance to learning that nearly all their other teachers reported. This supports the view that a good environment for learning is one in which the students feels affirmed and free to participate personally in the construction of their own learning (Watts & Bentley, 1987).

It appears that using journal writing can be a very rewarding experience, and an excellent method for students to make sense of their research and of the PhD process which can otherwise be a very frustrating process. It helps clarify ideas and discover new leads, and can increase creativity by allowing connections to be made and transfer to take place between information usually stored in disconnected compartments of the brain. It helps discover inconsistencies in thinking, forces one to be more intellectually honest and to confront a wider range of issues than are otherwise likely to be confronted, including moral and political issues, and makes one more critically aware. It helps overcome motivational problems, sustains the writer through periods when no-one else seems to want to hear, gives strength of convictions in the face of opposition, and makes the learning experience all worthwhile. This is regardless of whether the PhD is finished or not, although finishing is now more likely as the writer has so much personal investment in it. Finally it makes the writing phase much easier, since when it comes to formal writing, the issues have already been threshed in advance, and emotional baggage has already been removed, leaving only the pure grain.

I can usually justify what I believe in a scholarly manner by the time I've finished tussling with it, and a personal bibliographic base of more than eight hundred entries, complete (well, not all of them) with quotes and summaries helps me to do this, not to mention hundreds of pages of personal reflection.

As well, I'm moving more and more towards including myself as part of the research context and to acknowledge my findings--in spite of my efforts to socially validate them--as being my interpretation based on my meaning-making--given my background--rather than as objective findings in any sense. To be convincing about my findings then, I will need as much to communicate my own personal experience of the research effectively, as to demonstrate such qualities as credibility and trustworthiness. Most people I talk to (I wrote 'most men' but then changed it) see this point of view as self-indulgent--especially if they come from a science background, and particularly if they have had a traditional academic career, but other researchers, such as Valerie Walkerdine, argue that subjectivity is unavoidable and so must be presented as part of the research, in an attempt to evaluate its part in the process, or at least acknowledge it to the reader who can then judge its part in the process. Trying to avoid admitting one's own biases and assumptions in doing the analysis (and, before that, in framing the data on which it is based), seems to me to be hiding something from the reader which is important to the meaning-making process that the reader is trying to make sense of....

Re my proposal, K has a copy of it if you're interested in reading it. His response seemed to be 'Aye, it's delicious [read 'scholarly and well argued'], but that's NO' HOW YOU MAKE PORRIDGE! [do a PhD in science education]'. I'm afraid that I have to make porridge the way which makes most sense to me in 1995, and I can only wish the science education research establishment 'bon appetit' with their porridge!'

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